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ABSTRACT

This book consists of two complete units on soil. The first unit is created for lower elementary students and the second one is for upper elementary grade levels. The units are designed for gifted students and encourage students to be responsible for their own education. Each unit is based on an interdisciplinary approach. Suggestions for adaptation of the units are also included. (YDS)

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Earth Science
A Multifaceted Investigation of Soil

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A SELF-DIRECTED LEARNING EXPERIENCE

Each packet:

- **is reproducible**
- **requires little teacher preparation**
- **works well with the entire class, individually, or with a small group**
- **includes two group levels: K-3 and 4-8, a bibliography, and learning center ideas**

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Earth Science

A Multifaceted Investigation of Soil

by
Mary H. Brown
and Rosemary Dickinson

Self-directed study units
for grades K–3 and 4–8.

Process- and product-oriented
interdisciplinary learning through:

Evaluating
Imagining
Researching
Reporting
Thinking and reacting
Mapping and charting
Creating and appreciating
Classifying and comparing
Career exploration and goal clarification

Zephyr Press
Tucson, Arizona

Earth Science
A Multifaceted Investigation of Soil

Grades K–8

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The Premise

Learning Is Natural

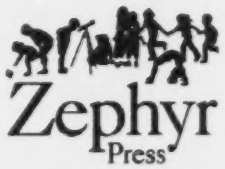
Children are active participants in their learning, not passive vessels to be filled.

They are always seeking and choosing what they will learn and what they will not learn.

Their interest, trust, and active involvement are crucial.

Children tend to become personally involved in projects that appeal to a variety of modalities—reading, writing, reasoning, building, imagining, and creating.

What a gift we give when we respect the child's natural need to explore, to reflect, to communicate, to dream, to celebrate!



(Available in poster form from Zephyr Press)

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A Word to the Teacher

Earth Science

Soil is more than dirt—it's the receptacle of life to come and life that has been. It is a rich element, and it is replete with possibilities of study. A study of soil can be a journey of discovery into the recent history of an area.

Myriad plants and animals live in soil. Of what kinds of organic and inorganic materials is the soil in your area composed? How does that composition contribute to the life in your area? What are the natural cycles that contribute to the composition of soil?

Your students may not realize the variety of careers that are related to studying soil. Some include direct interaction with the soil, such as farming or sculpture. Others must consider the impact of activities on the soil; city and highway planning, construction, and industry fall under this category. Regardless of their interests, students will find the study of soil a fascinating endeavor.

Rationale for Self-Directed Learning

Our children's education must be more than the memorization of capitals of states, products of countries, and dates and places of past wars. Most teachers and parents would agree that what is also wanted is for our children to learn to think for themselves, to make wise choices, to work independently, to evaluate thoughtfully the results of their study, and to use their knowledge and skills creatively.

Obstacles to Independent Learning

In spite of the teacher's best efforts, many, if not most, classroom programs involve students in schedules and organizational plans that foster dependence rather than the independence we prefer. Students are told what is to be learned and how long it will take them to learn it. The teacher not only defines the resources but also decides whether the learning experience was a satisfactory and valuable one.

A Learning Atmosphere

Each time we, as educators, focus on what our objectives are, we need to take a fresh look at our classroom mode of operation and evaluate the effectiveness of the way we teach. Quite naturally, for most of us, our teaching style has had more to do with how we were taught than with what recent research has shown about the learning process. Even our good instincts have been overcome by the years of conditioning we have known in our own educational processes.

Like a breath of fresh air, recent findings from research on the brain support our intuitive knowledge. This research shows that our brains are receptive to learning only under certain conditions. Our job is to translate that information into a classroom atmosphere that provides

- challenge
- freedom within structure
- trust and warmth
- recognition of each student's learning process
- opportunities to experience success
- personal involvement in the curriculum

A natural transition generally occurs that transforms the former "teacher-lecturer" into a "fellow learner." As fellow learner, the teacher becomes a resource person, a facilitator, and a classroom manager. In this maturing atmosphere, students gradually come to see themselves as responsible for their own learning, and a foundation for self-direction is set.

At this point, an unexpected problem sometimes arises. We find students no more ready for their independent learning than we, as teachers, were ready to allow it. This common occurrence is mentioned repeatedly in the literature dealing with programming for the gifted, an area in which independent study and research are recommended as major curricular activities. See Suggested Readings.

From Passive Learner to Active Participant

(Bridging the Gap)

The Zephyr self-directed study unit was developed expressly to bridge that gap: to transport the student from the position of passive recipient to that of an active participant in his/her own pursuit of knowledge.

Within the defined structure of each unit, students are given opportunities to

- make choices
- learn at their own paces
- learn in a manner suited to their own learning styles
- expand their research skills
- use a variety of modalities
- plan their own time
- develop the skills of creative, critical, and evaluative thinking
- experience whole-brain learning

Because assuming responsibility for directing their own learning is often an unfamiliar situation for students, they will need your encouragement at the start. Generally within six to nine weeks most students will be well on their way from teacher-dependence to self-motivation. (Beginning the venture with only a few choices, then gradually arranging the setting so that there are more and more choices works best.) As students assume more responsibility, many teachers begin to consider the school library as just another part of the classroom. Both teachers and students can benefit from the enormous resources available in most school libraries.

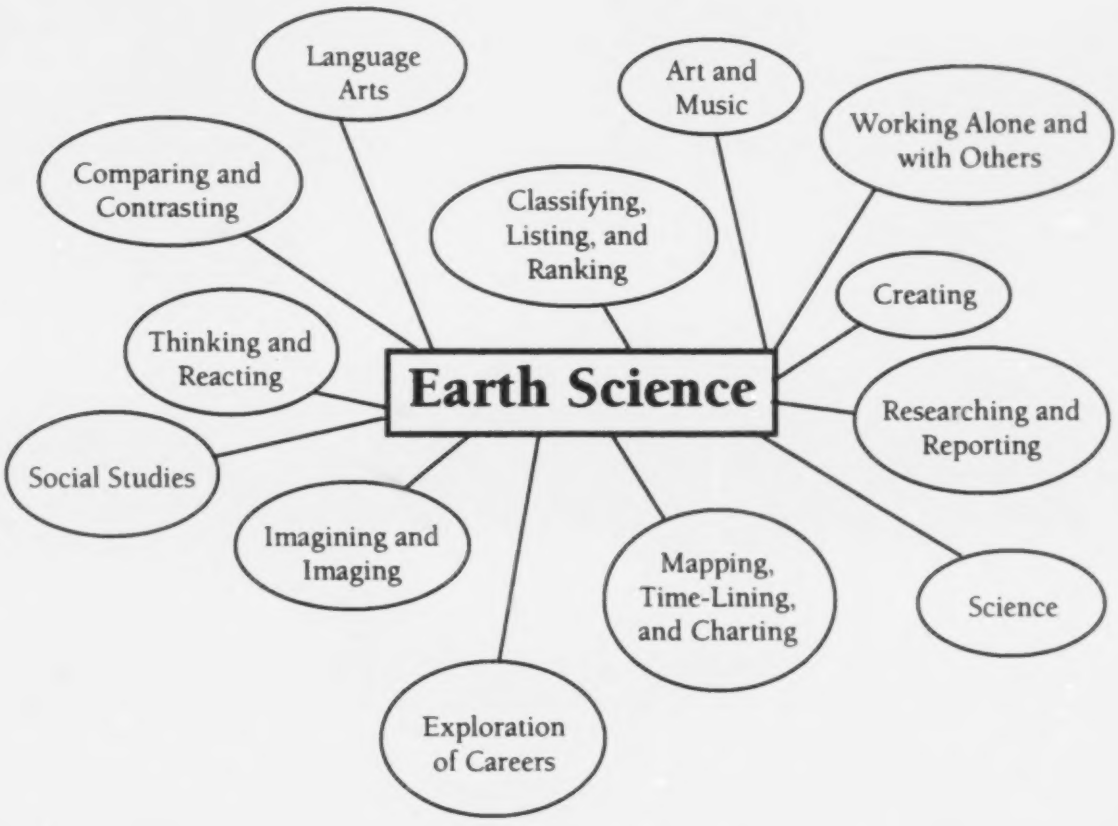
Eventually, a few students will be ready for a true investigative research study of professional quality as suggested by Joseph Renzulli in *Enrichment Triad Model: A Guide for Developing Defensible Programs for the Gifted and Talented.*

The Format

These units were originally developed for gifted students, but we now recognize that every child is gifted in one or more of the multiple intelligences. The units emphasize the use of higher-level thinking skills and are appropriate for use in any classroom where the goal is to encourage students to become responsible for their own education.

Interdisciplinary in content, each unit envelops a broad view of the topic by integrating the "basics" into each activity.

Within this book are two complete units: one created for the lower elementary student and one for the upper elementary student. Suggestions for adapting or adjusting either of the levels to fit any individual classroom are included.



Suggested Readings

Self-Directed Study

Armstrong, Thomas. *In Their Own Way: Discovering and Encouraging Your Child's Personal Learning Style.* Los Angeles: J. P. Tarcher, 1988.

Brewer, Chris, and Don G. Campbell. *Rhythms of Learning: Creative Tools for Developing Lifelong Skills.* Tucson, Ariz.: Zephyr Press, 1991.

Clark, Barbara. *Optimizing Learning.* Columbus, Ohio: Merrill Publishing Company, 1986.

Gallagher, James. *Teaching the Gifted Child.* 3d ed. Boston: Allyn & Bacon, 1985.

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Kline, Peter. *The Everyday Genius: Restoring Children's Natural Joy of Learning.* Arlington, Va.: Great Ocean, 1988.

Maker, C. J. *Curriculum Development for the Gifted.* Rockville, Md.: Aspen Systems Corporation, 1982.

Malehorn, Hal. *Open to Change: Options for Teaching Self-Directed Learners.* Palo Alto, Calif.: Scott Foresman and Company, 1978.

Miller, Ron. *What Are Schools For? Holistic Education in American Culture.* Brandon, Vt.: Holistic Education Press, 1990.

Purkey, William, and John Novak. *Inviting School Success: A Self-Concept Approach to Teaching and Learning.* 2d ed. Belmont, Calif.: Wadsworth Publishing Company, 1984.

Renzulli, Joseph. *Enrichment Triad Model: A Guide for Developing Defensible Programs for the Gifted and Talented.* Mansfield, Conn.: Creative Learning Press, 1977.

Stoddard, Lynn. *Redesigning Education: A Guide for Developing Human Greatness.* Tucson, Ariz.: Zephyr Press, 1991.

Udall, Anne J., and Joan E. Daniels. *Creating the Thoughtful Classroom: Strategies to Promote Student Thinking.* Tucson, Ariz.: Zephyr Press, 1991.

Getting Started

1. Select a topic as an extension of a regular subject (particularly when your class seems to crave more), or select a topic to pursue that is of particular interest and may not be a part of the curriculum. To zero in on special interests, administer an interest survey to each student.
2. Copy the unit for each student. When using these units for the entire class, you may want to expand or delete activities for individual students.
3. Set up a center in the classroom that encourages exploration in the subject field. You'll want to include a variety of materials. Be creative—the purpose of the center is to excite the students, so begin with lots of hands-on materials. Allow for ample browsing time and encourage students to investigate and become absorbed.
4. Go over each activity in the unit with the students, discussing and answering any questions. You, as teacher, are the key to successful implementation. Because most children are already well versed in the "One Right Answer" game, they will need encouragement to branch out into many of the open-ended activities in the packets.
5. Set the stage. Plan conferences and provide resources as needed. Then, get out of the way and let your students learn.
6. Give as much time as each student needs to complete each activity in the unit. The entire packet might take from five to ten weeks or longer.
7. As each activity is completed and evaluated, initial the activity near each number. You will want to evaluate on the basis of the response that is appropriate for each individual student.
8. When a student shows extreme interest in the topic, the completion of this unit might be only the beginning. This student may be ready for further study and research and may need only resources, guidance, and freedom to pursue his/her well-planned project.

Interest Development Center

Earth Science

The purpose of this interest center is to stimulate interest in the topic. Students need time for browsing and investigating for maximum benefit. These are beginning ideas; you and your students will think of more. Let parents and other teachers know about the center as well, and it will grow without effort.

Videos, filmstrips, books, and posters about

Cycle of plants
Composition of soil
Animal life in the soil
Gardening
Compost
Ecology of the soil
Pottery
Creation myths
Soil identification

Objects

Soil samples
Pottery from a variety of cultures
Ant farm
Earthworms
Magnifying glass
Spades
Small garden
Rocks

Art supplies

Water colors
Chalk
Oil paints
Polyform
Clay
Markers
Various textures of paper
Papier mâché

To Prepare for Further Research

Students will need to decide:

- What will the study be? What will be investigated and produced?
- Where will the background information be found (e.g., speaker, interviews, books, film, microfiche, documents)?
- What, exactly, will be the form of the product: a model, a manuscript, or . . . ?
- Who might be interested in the product: professionals in the field, publishers, organizations, or . . . ?
- What is needed to begin: specific plans, resources, deadlines, or . . . ?

Suggestions for Adapting the Unit to Your Particular Learning Situation

- Require fewer or more research sources.
- Assign more of the activities to small groups instead of to individual students.
- Give fewer or more choices.
- Delete some activities altogether.
- Arrange the unit as a class project and have students choose different parts to complete.
- Add some activities of your own.

Through the Chalkboard

by Mary H. Brown and Rosemary Dickinson

I bet you and I are a lot alike. I'm a typical sixth grader. I like cool clothes. I like music. I know all the right people. And I'm a pretty smart kid. I like school most of the time. I mean it's where your friends are, right? Well, I've got a story to tell you about my school. And it's the strangest story I bet you ever heard!

It's about my sixth grade teacher, Mrs. Lucas.

There's nobody like Mrs. Lucas. Even though she's always the proper lady, she's weird. I mean she is really different. She looks very old fashioned, and even kind of mean. Her gray hair is pulled back into a tight bun and she wears those dark dresses with the starchy high-necked collars. She talks kind of funny, too. Some of her words are so big, I can hardly keep them in my brain and they just barely stumble through my mouth. She tells our sixth-grade science class, "Always use the proper terminology when you're in this class. I will not tolerate inappropriate language." I know she isn't talking just about swear words. She wants all us kids to use the language of each subject. She says that using the proper language shows others that you truly know your subject. She really gets into her teaching, especially science.

There are other things that are strange about her too. She's less than five feet tall and doesn't even weigh one hundred pounds. When Mrs. Lucas stands in front of the class, some of us are taller than she is, and we're sitting down. You'd think that she'd be an easy teacher to handle, but she isn't. There's just something about her that you can't quite put your finger on.

It's really strange the way the eighth graders treat her. Lots of us have older brothers or sisters, and the word is always the same: "Don't mess with Mrs. Lucas." That's surprising in itself, because, well, you know how eighth graders are. They play tricks on all their teachers. They show no mercy for subs. So, why is Mrs. Lucas treated any differently? Not one eighth grader ever tries to pull anything on her! You know this really had our class baffled for the first month of school. Then we found out why.

I don't want to get ahead of my story. So, let me tell you about our school principal and Mrs. Lucas. Our principal's name is Mr. Screech, and believe me the name fits. Almost every day, Mr. Screech comes to our classroom and talks to Mrs. Lucas about her chalkboard. He wants to replace it. Her chalkboard is one of those old-fashioned slate blackboards on a wooden stand-up frame. There is even a large crack on one side of the wooden frame. Besides that, there are so many layers of old chalk that it's really a dark gray blackboard. It's a good thing it's not the only chalkboard in the room. There's a big, green, modern wall chalkboard that wraps its way around two sides of the room. Ever since I've known her, Mrs. Lucas has used only that big, green chalkboard. So why is she giving Mr. Screech such a hard time about the old chalkboard?

Mr. Screech says the old blackboard is inappropriate for the image of the Hampton Middle School. He says the old blackboard is incompatible with the reputation of our modern school. (Talk about a vocabulary, Mr. Screech throws words around just like Mrs. Lucas!)

One week, Mr. Screech was really desperate. I think the school board was getting ready for its annual tour. Mr. Screech told Mrs. Lucas that if she would only "consent to obtaining a chalkboard like the remainder of the faculty" he would get her a new color computer. Mrs. Lucas only shook her head.

The next day, Mr. Screech changed the offer to a color computer and a laser printer. Mrs. Lucas shook her head again.

The school board visit must have been getting really close; we could tell Mr. Screech was getting more desperate. The next day, Mr. Screech offered her a color computer, laser printer, plus a color TV hooked up with cable and VCR. We couldn't believe it. Mrs. Lucas said "No thank you, sir!" loud and clear! If she hadn't been teaching forever, and if our parents didn't sing her praises, well I don't think she would have gotten away with it. Being just kids in her class, it wouldn't do us any good to complain.

But, we did all wonder what was so special about that dumb old chalkboard. It was about a month after school began that the mystery began to unravel.

We had been studying **soils**. Mrs. Lucas wouldn't let us call it dirt. We did the usual classroom stuff. Our earth science class is taught by the hands-on science method. You've probably heard of it, but I'll explain anyway, just in case. It means that you have to be actively involved with what you study. In this case that means you

get down and dirty. Sometimes it can get pretty boring, but it beats sitting at your desk all the time. Some of the kids call it hands-on boring, but then I guess they are not much for proper terminology in anything, including science methods. The only thing I don't like about hands-on science is when you don't know exactly what you're doing, and then when you finish you really aren't sure what you've done. I didn't know Mrs. Lucas well enough then to know whether we would know what we'd done when we'd finished. Call me crazy, but I just like to know!

One thing I did know about Mrs. Lucas is that she doesn't seem to know where earth science leaves off and other sciences begin. I mean, she doesn't always follow the book. That drives me nuts. Just when you think that she's going to give us a lesson on some new topic, she starts putting the chemistry, biology, and other "ologies" into the topic we just finished. One part of me thinks it's kind of neat to think that we get to study stuff that seventh and eighth graders are having now. But another part of me thinks that's unfair! I mean what will I have left to study in science when I'm older if Mrs. Lucas insists on covering everything now! I'll be bored by the time I'm 15! So be forewarned. Mrs. Lucas slips a little biology, entomology, zoology, and even chemistry or physics into her earth science every now and then and thinks it "challenges" us. Some days, I could put the word *frustrates* where she says challenges.

Well, as I was saying, we did the usual stuff. First, we gathered samples of dirt (excuse me—as Mrs. Lucas would say, soil). We got samples from almost everywhere. One kid got his sample from the creek bed that runs by the school. Another took her sample from her barnyard. It even had some manure in it! Gross! One kid took his sample from a park near the school. Well, I'm sure you get the idea.

We all had to have similar size samples, so we had to fill a mayonnaise jar or a canning jar. My Mom was mad because I needed the mayonnaise jar and it wasn't empty! She had to find something to store that last bit of mayo and then she was sure we wouldn't eat it! The sacrifices we make for science!

We used our earth science books to name the different kinds of dirt. We put labels on the jars. My sample was pretty easy to label. I took it out of our garden. It had a **humus** layer (my Dad **mulches** well!), a layer of **loamy sand**, a layer of **sand**, and a bottom layer of **gravel**. I even labeled it **O horizon**, **A horizon**, **B horizon**, **C horizon**, and so on, just like it showed in the book. Then we each had to give an oral presentation to our class about our **soil profile**. Boring!

You know how some kids can fall asleep while watching anything educational. Well, most of us had done just that. It's a pretty neat trick if you don't get caught with your eyes closed!

When the last report was finished, Mrs. Lucas asked Rachel to clean the old chalkboard. Now, this was pretty odd for two reasons. There wasn't a thing written on the board. But Mrs. Lucas can be pretty weird some days so this didn't really bother us. The second reason that her request was so odd was that up until that day Mrs. Lucas had never let any of us touch that chalkboard. Not that we were dying to or anything. But we had all heard her refuse to trade that chalkboard to Mr. Screech on several occasions. So now why all of a sudden does she ask Rachel to erase an empty chalkboard? It didn't really add up. At that moment we should have guessed we were in for adventure, but we didn't. We just sleepily watched a bewildered Rachel go to the old chalkboard and lift an eraser.

As soon as Rachel placed the eraser to the chalkboard, something strange happened. The whole room was suddenly filled with chalk dust. There was a fine cloud of dust everywhere. It took a long time for the room to clear enough so we could see each other again. But when it did, we couldn't believe what we saw! The walls of the classroom were gone. Mrs. Lucas awkwardly stood in front of us with the heavy old chalkboard complete with wooden frame in her hands. The chalkboard was the only reminder that our classroom had ever existed. All of us kids and Mrs. Lucas had been reduced to the size of microbes and were standing in soil knee deep!

It was clear to me we were no longer in the classroom. There wasn't this much soil in any of those samples, and as we looked up, we could see a clear, bright-blue sky. No, we certainly were not in any classroom. But Mrs. Lucas didn't look the least bit surprised. She looked as if this was just as she had planned.

The first thing I did was to have a good look around me. Now, I knew something about dirt (or soil, as Mrs. Lucas says) from the reports and stuff we had to do. Even though I know that soil is a combination of many particles, it's still hard to describe when you're the same size as those particles. First I noticed all the spaces between the soil particles. It was kind of easy to notice these, because that's what we microbe-sized kids were standing in. Those spaces are called **pore spaces**. They are storage areas for air and water.

Luckily for us it hadn't rained lately; otherwise the pore spaces we were in would have been filled mainly with water and only small amounts of air. I remember thinking that with my luck, the janitor

(Mrs. Lucas calls him the environmental custodian) would pick just this minute to turn on the sprinkling system. It didn't happen, though, so I must have better luck than I thought. As for Mrs. Lucas, she declared aloud her "gratitude for the spacious and dry pore spaces that we're in."

As she did so, another strange thing happened. The old chalkboard rose to attention. It had shrunk to a miniaturize chalkboard, so it was normal size to us. The whole class watched awestruck as letters appeared on the board. No one looked away until the magical writing had stopped. The chalkboard had written the words "PORE SPACE—THE OPEN SPACE BETWEEN SOIL PARTICLES CONTAINING AIR AND/OR WATER." Right then I was thinking, boy, could I use that old chalkboard during a science test. I think most of the class was thinking the same thing. I heard John say in a respectful whisper, "Man, I could sure use one of those!"

When the class was again able to direct its attention away from the chalkboard, we saw many different soil particles. For some reason, my mind went back to the classroom stuff. We began to bombard Mrs. Lucas with questions. Considering we were half asleep only a few minutes before, it was amazing. Someone asked, "How did those huge rocks get into the soil?" Another question was, "What is that large paper stuff?" And a third question was, "Is that a dead leaf?"

Typical of old Mrs. Lucas, she demanded that we reason out the answers. She uses a trick that she calls wait time. We call it suffer time. She won't even tell you if an answer is wrong or right. She wants us to keep thinking! She has told us several times that if she gives us too many clues we don't think for ourselves. So she just waits until almost everyone in the class has said something about the question being asked. For some of us kids that never like being wrong aloud, she waits a long time. And that's the worst part. Even when you think that the silence is going to kill you, she's still content to wait. I have to admit that even I have come up with some great answers, but it's hard work. Mrs. Lucas acts as if she were deaf to that sort of complaint.

Well, we filled that old blackboard with possibilities about where all those rocks might have come from. I thought some ideas were pretty unusual. Some kid suggested outer space and I had to cover my mouth not to laugh right out loud. Mrs. Lucas gets pretty angry if we make jokes about other people's answers. She's pretty cool that way. You kind of get the feeling that you could say almost

anything that comes to your mind and she wouldn't let anyone make fun of you. Sometimes they get you after class, though, and sometimes the funniest answers are right, so you get the last laugh.

Another kid said volcanoes. I was hoping that wasn't a right answer. When I think of volcanoes, I think hot and dangerous. I've seen these pictures on TV that show fire rolling down the sides of a mountain. I can't even imagine them being the source of rocks. But Mrs. Lucas said they could be. I was a little surprised at the answer. Huh, so volcanoes can actually form rocks. Well, I guess I learned something new! When Mrs. Lucas talked about volcanic rocks, she also told us that we would be studying volcanoes next month. That didn't go over very well. Most of us groaned. She also told us that we would be studying rocks and their origins as the following unit. I guess she wants us to anticipate, as she puts it, but even my Dad says "anticipation can be worse than participation." There are some things you'd really rather not know ahead of time, you know what I mean?

Well, sure enough, when she finally did start to answer our questions, she told us that some rocks do come from outer space! Can you believe it! She also told us that the rocks are the source for the minerals in the soils. By that time, we had also figured out that these "huge rocks" were probably only the size of the rocks we had put in our hands when we were normal sized. They weren't big boulders! She reminded us again that rocks are a topic for later in the year. Just like always, we groaned a little. But even then I began to wonder just what she had in mind for studying rocks, particularly volcanic rocks.

We had to get up close to look at the "papery stuff" in order to answer the next question. We discovered that the papery stuff was just that. Paper. It was just so large that it could easily have covered ten of us. Once we could figure out the huge colored letters, we found out it was the wrapper of a bite-sized candy. I felt my face get a little warm at that discovery. Usually, I'm pretty good at remembering the waste basket and the scraps of papers in my pocket. Every now and then, though, one gets away from me. As a big fan of candy, I couldn't help but wonder if this huge foreign invader in the soil was there because of a careless kid who occasionally drops candy wrappers. I wanted to think that kid wasn't me, but I didn't know that for sure. When I looked around at my friends in the class, I discovered that I wasn't the only one who was wondering whether this paper was in his pocket a short time ago.

Mrs. Lucas didn't seem to be bothered by our silence. She talked about the **biodegradability** of paper and speculated that without interference from human resources that paper might take fifty years to decompose and become completely part of the soil.

We also had to get closer to the dead leaf to discover if it really was a dead leaf. It was. You could see the crumbling papery material that was originally the fleshy green part of a leaf during the summer. It was brown now and had a pattern like a spider web running through it. When we touched it, only the tough vein around it remained and the rest crumbled to a fine powder. The leaf powder drifted slowly and became part of the soil around us.

"Now, it's my turn to ask some questions," said Mrs. Lucas. Uh oh! I knew that Mrs. Lucas has a definite way of asking questions. She starts with the easy ones first. It's kind of like asking if you've been paying attention. Then she works her way up to the hard ones. I like to get my hand up for the first one if I know the answer. She has a regular routine she goes through. First come the knowledge questions, then comprehension questions, then application questions, then synthesis questions, and then analysis questions. Just when you think it is safe to raise your hand again, she comes up with evaluation questions. She actually takes pride in making us think! She is always telling us that we "must respond to higher-order thinking questions" when the class goes silent at the last set.

Mrs. Lucas asked us, "What is the primary mineral matter of this soil?" I thought, "Oh no, she must be thinking that we've already answered the knowledge questions, and she's going directly for application!" I waved my hand to answer and she actually called on me when I knew the right answer. I said, "The mineral matter of the soil we're in is mostly loamy sand. If it were only sand, we wouldn't be surrounded by so much humus." I was so proud of myself. I had remembered the proper terminology.

After a smile in my direction that showed her appreciation for such a brilliant response, Mrs. Lucas reminded the whole class that "humus is the organic material created by plant and animal matter that gets mixed in with the minerals of the soil. And without humus the soil could not support plant growth."

Then she added, "The leaf we just saw is part of the humus. What other types of plant matter could we possibly find in the soil around our school?"

Of course, Nathan, one of the brightest kids in the class, answered this one. "Since there are so many trees around our school,

I would guess that tree limbs and small twigs that break off from the trees might find their way into the soil."

Knowing he was on the right track, Nathan continued, "Decaying plant and animal matter actually provides our environment with fertilizer to support plant and animal growth. Animals, including humans, rely on plant growth for food." Why didn't he ever find it difficult to use proper terminology?

Once Mrs. Lucas had spoken the word **humus** aloud, the chalkboard had erased the definition of pore space and had given us the definition of humus. It wrote: "HUMUS—THE PART OF THE SOIL THAT IS MADE UP OF THE REMAINS OF PLANTS AND ANIMALS."

I liked that chalkboard more each minute. It might come in real handy in the classroom. I also thought I wouldn't need to take any notes from the board if all you had to do was tell it the word and the definition would magically appear. I wonder if you could find a notebook that worked that way—it would be much more portable. I was beginning to really like this class.

Mrs. Lucas brought us all back to attention with another question. "How can we tell that our new environment is not **clay loam?**"

Once again, my brilliance paid off. "Oh that's easy." I said. "If our new environment had been clay loam, we might have drowned in the water captured in the spaces between the mineral particles. But sand allows water to move through it quicker and easier than clay soils do."

I glanced toward old Mrs. Lucas and did she look different. She was actually beaming with pride at me! Then she turned her attention to the whole class and encouraged us to "liven up our oral reports with observations made on the site." Unlike with some activities, she really didn't need to tell us twice.

It was easy to spot **sand** particles; they showed the **siliceous** structure we'd seen in the book. The **loam** particles were minerals of various sizes and structures. There didn't seem to be a predominant shape or type, just a jumble of different types of small rock and mineral pieces. I noticed Mrs. Lucas managed to sneak a little chemistry into this unit. The chalkboard helped us out, though. It made a pretty neat drawing of the crystal structure of **silica,** the mineral of sand. It even labeled the **oxygen** and **silicon** atoms and showed them in different colors! Slick! You know, the structure of crystals is really chemistry. I wondered if the tenth graders in chemistry had learned that yet.

Mixed within the different crystal structures of the minerals was plant and animal matter. There were pieces of old leaves, plant stems, seeds, and other plant parts. We could even see the **tap root** of a big plant. We guessed it was a dandelion. It was hard to know for sure from our height. Anyway, the little side **rootlets** from the tap root were actively moving water toward the stem. If it was a dandelion it was the largest one I'd ever seen!

Mrs. Lucas remarked, "Luckily, the humus level in this soil is not high. But the odor is peculiar!" That's about the kindest thing that you could say about it. If you can imagine sticking your nose about one foot into the ripest part of a garden **compost** pile, that's exactly the odor we experienced. Earthy is a good term for it! One of the kids said, "Good old Mother Earth—she needs a bath or else a good deodorant." Everyone laughed, including Mrs. Lucas.

"Besides plant life, what other types of life forms do you detect?" Mrs. Lucas asked us. I knew that she was trying to get us to continue looking around us, and it sounded like a good idea to me. She also was moving right along and putting a little biology into this. Okay, as long as I know it's coming.

I was surprised by the amount and kinds of life present. There were lots of living creatures within the soil. Most of the living things looked like simple **bacteria** that we had seen in our earth science book. There were round cells, some in groups and some strung together in chains. Other bacteria looked like small rods. There were single-celled plants and animals too. Some were living in the few pools of water. Even I recognized **euglena, paramecium,** and **amoeba.** Some were feeding off the bacteria around the mineral shapes! Tracy said, "This is pretty neat to watch, but I don't want to get too close!" Who could blame her!

We walked around in the soil a little bit. In the near distance one kid saw **larva** cases of insects. And another kid spotted large clumps of insect eggs.

Some kids said maybe we'd run into a **pill bug,** a **centipede,** or a **millipede!** I was just as glad that we didn't see any of those! Not that I would normally mind, but I'm not usually the size of a microbe, and what happened next was scary enough.

First we felt and heard something like the wind. It wasn't really the wind. It was the noise you might hear and the changes in the air you'd feel if things around you were gently falling. The noise and the air movement got stronger, but it still sounded like it was quite far away. It was eerie though, and it put my teeth on edge.

"Attention class!" Mrs. Lucas called to us in her usual manner. She said, "Class, I believe we are now experiencing the **vibrations** called **sound waves**. I **hypothesize** that a person's footsteps are the causal agent."

I gasped as I realized she meant a normal-sized person was walking toward us microbe-sized kids.

We froze in our pore space places as Mrs. Lucas continued. "Our primary danger is **compaction.**" The chalkboard automatically did its magic trick again and wrote: "COMPACTION—A REDUCTION IN THE NUMBER OF PORE SPACES PER UNIT."

But, that means . . . I looked around me at the roomy pore spaces that we had all been walking through. I imagined the spaces not being there. I imagined us becoming part of the humus! My next thoughts were, "I want to live! I'm too young to die! "

I got a much better idea of compaction almost instantly. You might even say hands-on participation. But it's not what you think. The vibrations continued to move closer to us. Then they seemed to stop. Then they changed direction. We couldn't help ourselves! As soon as we realized we weren't likely to be crushed by a sudden compaction of pore spaces, we started to cheer and scream for joy! That caused our next problem.

The sound waves we caused by our screaming and shouting made a minor **avalanche** of soil particles slide down right over the top of us.

Luckily, most of us were able to move quickly out of the way. It must have looked very funny to see a whole class of kids all jump together to the right! It made me think of band practice, when the whole group moves together in one direction. Except this time, everyone was all together. Except Joey. It was like a scene in a horror movie when a whole clump of soil particles suddenly buried Joey from our sight.

Joey screamed frantically, "Help me! Help! Please help!"

We knew we had to get him out quickly. Just as we started over to dig him out, a huge ant appeared. We all froze in our tracks, too frightened to move. Joey couldn't see the ant, so he kept on screaming. The ant started moving slowly toward Joey. We held our breath wondering just what the ant would do. The ant started to move the soil particles from around Joey. It was actually digging Joey out! Why?

We looked at Mrs. Lucas and Stacy asked the question that most of us were too terrified to ask. "Mrs. Lucas, will the ant eat Joey?"

Mrs. Lucas looked a little less calm than normal but still very much in control. She thought for a second than quietly said, "It appears to be a **thief ant, genus *Solenopsis*,** and there is a possibility it would consider him a food source."

I said to myself, "What she is saying then is that he might eat Joey, right?" AAHHH! I stared at Mrs. Lucas and tried to control my own panic. I figured she would know what to do.

I told you Mrs. Lucas is weird. She immediately asked Travis very calmly if he had his usual candy bar in his pocket. He nodded. She said "Travis, unwrap the candy bar, please."

We noticed the ant was getting closer to Joey. We could see Joey's face. We started telling him to run as soon as his legs were free! "Run, Joey, run," we said in a soft chant—we didn't want another avalanche.

Mrs. Lucas calmly asked us to be quiet. And then she told Travis to throw that candy bar as far as he could "over and beyond the ant."

Travis obeyed instantly. It's a good thing that Travis pitches for our baseball team, because that candy bar went sailing right over that ant. The ant stopped. His antenna waved in the air in a searching-like motion. He seemed to be probing for the source of the new smell. He turned around, walked over to the candy bar and placed his antenna on it. Then he picked up the candy bar and carried it out of sight. We all sighed in relief.

After we helped Joey up and made sure he was all right, we cautiously looked around us. Maybe we should be a bit more careful. We saw some strange, see-through worms. We could see their body parts inside. It reminded me of one those models in the classroom—you know, where you can see all the parts through the clear plastic skin. These worms were moving fast. I wished they would slow down so I could get a better look, but I didn't want them to move too close to me.

One came so close to Sally that it knocked her down. She was okay, though, just a little surprised to be pushed by a fast-moving **nematode.** At least that's what Mrs. Lucas and the chalkboard called it.

Like any teacher, Mrs. Lucas said she wasn't going to let any "educational opportunity" get away! She leaned the old chalkboard against the huge stem of a nearby blade of grass and began to write soil terms on the board as we told her things we could see.

As we pointed out different things to her, she identified each animal and plant by its scientific name. This seemed a lot like our classroom now, but it was somehow different. I mean we were not in our classroom, and yet we were doing classroom stuff. Seeing it and being a part of it made it real for us. Mrs. Lucas always says, "Learning

in the classroom is preparing us for experiences outside the classroom." I think I finally had an idea of what she was talking about!

I couldn't believe it. I think I learned much more than I ever had before in a science class. I was also having fun in school! Well, it wasn't exactly in school, but at least at the school. I was having fun learning and that's what school is all about. Isn't it?

Just as I was thinking about how much fun this adventure had been, I heard a strange sound. It sounded like the sucking sounds made by a gigantic vacuum cleaner. Suzy guessed it might be the feeding sounds of some large animal.

Mrs. Lucas responded, "Suzy, your deductive reasoning skills are excellent. I believe the animal in question is an earthworm, or genus ***Lumbricus***, a member of the class ***Oligochaeta***, **order** ***Annelida***. She went on, "Earthworms eat **detritus**, or the **organic** material in soils. They mix soils by moving through the mineral and organic portions of the soil and through that action, they aid the movement of water and air through soils."

I immediately translated her proper terminology to common English for myself. Mrs. Lucas meant the earthworm mixes the soil with plant and animal matter and helps the water and air get into the soil to help with plant growth. I was finally getting the hang of this and could put it into my own words. I was learning something!

Before Mrs. Lucas could say anything more about the earthworm, we heard a noise something like a helicopter. The noise had a repeating quality about it. A sort of whap, whap, whap without any mechanical engine noises. Whatever it was, it was deafening. The sucking sound was no longer important. Jim spotted a partially submerged tunnel behind us. We all raced into it.

The tunnel seemed safe but odd. There was a white rolled lip above us all along the entrance. The walls and ceiling were a dusty, off-white color. It was huge, and soil only partly filled the tunnel. Some kids were brave enough to go all the way to the back of the tunnel. There didn't seem to be a rear exit. Amanda leaned against the back wall and brought her hand back sticky from some brown junk. Jerrard noticed an odor. It smelled like a cola. Even in our nervousness we joked about that. Was it a cola or an uncola? And we decided we must be inside a thrown-away paper cola cup. Nathan saw some letters through the thin paper ceiling, and we knew we were right.

Most of the class stood at the entrance to the cup. We looked outside as the helicopter noise got louder. All of a sudden, the noise

stopped. All was quiet. We didn't even hear the sucking noise of the earthworm. Wherever he was, he had suddenly stopped and become very still. All of a sudden, we heard a loud thump as if the flying object had landed somewhere near us. We peeked out of our tunnel and could see two huge, brown, scaly feet! There were three toes on each foot—two in the front of the leg and a smaller toe behind. There were even long, pointed claws on each toe. Yikes! What was this?

We turned to Mrs. Lucas. She was a little less calm than usual. She was watching the feet, too, but she seemed more worried about the chalkboard. It still lay where she had put it, against the blade of grass. The feet had not even knocked it over.

We watched the feet, and from our view in the cup, they were huge. Attached to the feet we could see a mountain of orange. It was hard to tell from our place in the cup what that orange mountain could be.

Nathan, his usual inquisitive self, started firing questions. It sure got us thinking. "What animal do you think those feet belong to? Do you think that animal might be after the earthworm? What animal would eat an earthworm?"

We looked at Mrs. Lucas for some clues, but she was still staring at the chalkboard. We thought the best thing to do was to try to answer the questions. It was better than thinking about the dangers in front of us. We also thought we couldn't be in too much danger from these feet, or Mrs. Lucas wouldn't be so worried about the chalkboard. Or, maybe this was her idea of wait time again.

Our scientific deductive powers were pretty sharp by then. The only thing I could think of with feet like that were birds.

Well, Nathan got all excited about that answer. "Yes, that's it! It must be a robin!" That got Mrs. Lucas's attention. She calmly answered, "Of course, ***Turdus migratorius,*** the American robin." Just then, the feet moved closer to us. Our view in the tunnel became a close-up view. Then, just when I thought I'd seen enough of bird feet, the bird stuck his head inside the cup.

The sight of a huge, yellow, pointed bill coming toward you is pretty scary! We all kept quiet. The earthworm kept quiet. The robin just flipped his bill against the top rim of the cup. Then he trained one eye on us by turning the side of his head and looked at us as if we didn't fit his idea of a juicy morsel. He hopped away. Jill was right when she said, "Wow, that was close! Too close for comfort!"

Mrs. Lucas left the cup as soon as the robin had hopped from

the entrance. She headed straight for the chalkboard. As we all marched out of the paper cup, Rachel spotted the earthworm. It had been keeping quiet when the robin was near.

It suddenly started coming toward us. The sucking sounds began again. I thought to myself, "Oh, no, here we go again." We still weren't out of danger. How were we going to get out of this one alive? I could just imagine the ultimate in disgusting deaths—being consumed by an earthworm. Oh, no, even my thoughts were beginning to be invaded by proper terminology!

I remembered Mrs. Lucas saying something about earthworms eating detritus. I thought, "I don't know anyone who carries detritus in their pocket!" The trick that Travis played on the ant wasn't likely to work again unless there was someone in our class who collected dust, complete with **dust mites.**

Meanwhile, Mrs. Lucas calmly picked up the chalkboard. Rachel asked her a very important question. "Mrs. Lucas, you said that earthworms eat organic material. Well, doesn't organic mean living, or at least had been living?" Mrs. Lucas looked at Rachel with pride for such an intelligent question and said, "Yes, that's exactly what it means." She admitted shyly to us that "the earthworm might consider us organic matter." With one swipe of the eraser she carried in her pocket, our soil surroundings filled with dust.

The bell rang! We were all back in class and normal size as if nothing unusual had happened. Mrs. Lucas was telling us to do some serious thinking about improving our oral presentations. "Remember, this time I want them to be more interesting! We'll go through our usual question routine for discussion. Remember, anticipate those higher-level thinking questions. Class dismissed. See you Monday with some good ideas for your new presentations." We shuffled our books and our soil profile samples and walked in a daze to the next class.

As I was walking out of class, I stared at the soil in my soil profile sample. I thought about all the things I had seen within the soil during the last hour. I thought about the pore spaces that we had been in and how lucky we were it hadn't been raining and that the sprinklers hadn't been turned on while we were microbe size. I thought about different soil types we had seen. I thought about all the living creatures and dead materials that I had seen. And I also thought about the changes made by the human walking across it and my fears of being under that foot, and the changes made by humans who carelessly throw things away. I even thought about all the other

incredible adventures we'd had inside soil. And I wondered. Had it all been real? Or had I fallen into such a deep sleep after those boring reports that I had one whopper of a dream?

It seemed impossible to me that we had been inside soil. If it was real, it also seemed impossible that Mrs. Lucas had always seemed in control of each situation. She always acted as if nothing unusual had happened. The only time I remember seeing her even a little worried was when the robin was close to the chalkboard. I told you she is weird. But now, I was beginning to wish all my teachers were weird like she is.

When the bell rang at the end of my last class that Friday, I picked up a clump of dirt just outside the school door. I stared at that clump of soil. It still seemed impossible to me that we had been inside something like what I held in my hand. It still crossed my mind that I might have been just daydreaming again. But I don't usually waste my dreams on school stuff. Then I found something that really made me wonder. In that handful of soil that I picked up was an earthworm covered with chalk dust!

Mrs. Lucas had a quiz on soils the following week and here are some words that she asked us to know. I'll give these to you just in case your teacher is anything like Mrs. Lucas:

A horizon: a layer of soil below the O layer. It gradually becomes coarser as water removes the fine materials.

Amoeba: a microscopic, aquatic, one-celled animal that feeds on other organisms in stagnant water.

Annelida: the group of worms that, like the earthworm, are segmented or appear to have divisions on their bodies.

Avalanche: a large amount of loosened earth (in this case soil particles) or snow that suddenly slides down, often growing in volume as it comes down.

Bacteria: one-celled organisms, visible only with the microscope (in usual situations!), which have no chlorophyll and multiply by simple division. There are three main forms: spherical (cocci), rod-shaped (bacilli), and spiral (spirilla).

B horizon: a layer of soil immediately below the A horizon. It is also called the subsoil, or the zone of accumulation. It accumulates the finer particles that have been leached from the A horizon.

Biodegradability: the ability to be decomposed by bacterial action, or the action of other living organisms, to become part of the soil.

Centipede: member of the phylum *Arthropoda*, class *Chilopoda*, which has at least 17,999 species. Centipedes have narrow, extended bodies and between 15 and 173 rings. They are venomous. On each ring is a pair of legs. The head has a pair of long antennae and two pairs of jaws for breaking down food. They hunt other Arthropods.

C horizon: a layer of soil below the B horizon that is primarily the weathered bedrock, or the materials from which the other horizons have their origin. It has little organic material.

Clump: a large group of soil particles.

Compaction: a reduction in the number of pore spaces per unit of space.

Compost: a mixture of humus, bacteria, and the products produced in the breaking down of previously living material into its original parts.

Crystalline: having a specific arrangement of atoms.

Detritus: the living and once living materials of soil. This would include all the remains of visible plants and animals plus the microscopic plants and animals of the soil.

Dust mites: close relatives of the spider, these tiny organisms live in house dust in great numbers.

Earthworm: a round worm with segments, or divisions, on the body, and that burrows into soils.

Euglena: a one-celled organism that is capable of making its own food. It is aquatic.

Genus: a main subdivision within the biological classification system that helps to distinguish similar organisms. The genus is a division within a family of organisms.

Gravel: a loose mixture of rock fragments and pebbles.

Humus: the part of the soil that is made up of the remains of plants and animals.

Hypothesize: to make an educated guess based on observations.

Larva: an early form of an animal that changes shape when it becomes an adult.

Loam: a type of soil that has many particle sizes within it, and thus no specific particle size is the main type.

Loamy sand: a type of soil that has a combination of sand and loam as its major components.

Lumbricus: the genus name (the first part of the scientific name) of the earthworm.

Millipede: a member of the phylum *Arthropoda*, order *Diplopoda*. Each segment of the body has two pairs of legs. Millipedes are less aggressive than centipedes and feed on decomposing materials. They can give off a bad odor.

Mineral: a naturally occurring, nonliving crystalline material that is made up of a specific chemical.

Mixture: containing two or more elements, not necessarily in equal amounts.

Mulches: the leaves, dried plants, or other materials that are spread on the ground around plants to prevent evaporation of water. If the materials spread are organic, they increase the amount of humus in the soil.

Nematode: a type of worm with a long body.

Observation: information that comes from the eyes, ears, nose, mouth, or touch receptors in the body.

O horizon: the top layer of soil. It contains mostly organic materials. The upper portion of this layer is primarily plant litter and other organic materials.

Oligochaeta: another grouping that includes the earthworm. This grouping means "having few bristles on the body."

Order: a grouping in scientific classification. It is a larger grouping than family but a smaller grouping than class.

Organic: having characteristics of or having come from living organisms.

Oxygen: a gaseous chemical element that very readily combines to form compounds with other elements.

Pill bug: also called the sow bug, it is commonly found under stones or bark. It is a member of the phylum *Arthropoda*, but having seven little leglike appendages, is in the class *Crustacea*.

Pore spaces: the open spaces in rocks and soils containing air or water.

Rootlets: little roots, or as in this story, a small branch of a large root.

Sand: the small-sized particles formed from the breaking down of rocks and minerals. Most sand is from quartz rock and thus has a silicon-oxygen tetrahedron as a building block. That means that the structure is made of four oxygen atoms with a smaller silicon atom between them.

Silica: a hard, glassy mineral found in sand and quartz.

Siliceous: containing silica.

Silicon: a common and abundant chemical element. Readily combines with oxygen to form silica.

Soil: a combination of mineral and living matter, water, and air. It supports the growth of plants.

Soil profile: a vertical presentation of soil that shows the layers within the soil. Immature soils lack horizons.

Solenopsis: a genus name for the group of ants that includes the thief ant.

Sound waves: a disturbance of air molecules that, when the molecules reach the human ear, is interpreted by the brain as sound.

Tap root: a type of root with one main large branch with rootlets joining.

Thief ant: the common name for *Solenopsis molesta*. It comes into the house when the weather is very warm, especially in the western and southern U.S. It eats sweets and proteins.

Turdus migratorius: the genus and species name for the American robin. Other thrush species also belong in the genus *Turdus*. The species name, or specific name for the American robin, is *migratorius*.

Vibrations: the movement of air molecules through a disturbance.

Earth Science

A Multifaceted Investigation of Soil

Name _____ Date _____

Unit 1

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1. Setting the Stage

Another word for "dirt" or "ground" or "earth" is "soil." Soil is full of rocks, living things, water, and air. Most plants need it to grow.

Imagine that you are as tiny as an ant. Imagine that you and your friends could make tunnels in the ground like ants do. Think about what that would be like. Imagine some of the different kinds of soil—sandy, rocky, muddy. Think of other kinds. Think of the type of soil you would like to make a tunnel in.

★ Draw a picture of your tunnel.

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2. Pavement

Make a list of places near your home or school that used to have grass or sand or just plain dirt that are now paved. When an area is paved, will it be harder or easier for water to get into the ground? What might happen in a paved area if it rains a lot? Where does the water go? Do an experiment:

Put sand or soil in something big—a bucket or a fishbowl or whatever is handy.

Sprinkle a cup of water over the soil and watch how it seeps in.

Now put a piece of plastic or cardboard over part of the soil and sprinkle a cup of water over it. Where does the water go?

★ Draw a picture of an empty lot or field that has been paved. Then show what happens when it rains hard.

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3. Research

Find out the names of five to ten types of soil.

★ Find at least three different types of soil. Put each kind in a glass jar. Label the jars. Show the soils to friends.

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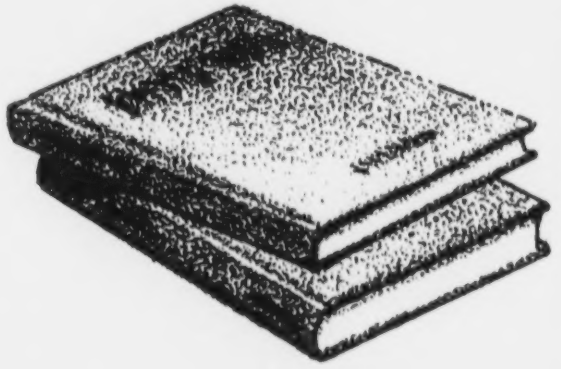
4. Stories of the Earth

Look at the list of fiction books listed in the bibliography. Choose one to read. While you are reading it or having someone read it to you, think of the soil. In your mind, make a picture of all the soil in the story. When you finish, imagine that you are the soil. How would the story be different if the soil were different?

★ Make a mural or a diorama showing the soil in the story.



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4. Stories of the Earth *(continued)*

CHOOSE ONE

- ★ Choose a part of the story that is not illustrated and make your own picture.
- ★ Draw a picture showing some different kinds of soils. Explain your picture on the back or on a separate piece of paper.
- ★ Draw or paint a picture of one of the characters in the story. Write three words about the character.

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5. Mud Pony

The Mud Pony is the story of an American Indian boy. The boy makes a pony from clay. The boy becomes a chief of his people. See if you can find this story in the library.

THEN

★ Make up your own story about making something from soil. Write it in book form.

OR

★ Tell how rocks are made or what happens to the leaves as they fall.

Tell your story to some friends.

Then make a mural about your story it.

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6. Writing about Soil

Have someone read "Through the Chalkboard" to you. Then choose one of these activities:

- ★ Pretend you are Joey. Tell the avalanche part of the story.
- ★ Is the person telling the story a boy or a girl? Does it matter? Why or why not? Write down your answers, or tell your answers to a friend.
- ★ If you are a boy, pretend you are a girl. Tell part of the story. If you are a girl, pretend you are a boy. Tell part of the story.

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7. More Stories

Think about the next chalkboard adventure. Mrs. Lucas's class might visit a volcano. The class might study layers of rock. What might happen in these stories?

- ★ List some possible other places for good stories.
- ★ Pretend you are a bit of soil. Name yourself. Keep a word or picture diary for one week. Tell what happens to you each day. Be creative!

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8. Creating a Play

★ Find some friends to work with. Choose one or more scenes from "Through the Chalkboard." Put on a play for your class. Include a part for each person in your group.

You might have someone tape the play.

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9. Vocabulary

Find out what these words mean:

erosion	**volcanoes**
acid rain	**drought**

★ Make a chart or diagram or tell how these things change the soil.

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10. Compost

What is compost? Does anyone in your family use compost in a garden? How do you make compost for a garden? How would a compost pile help gardens produce more?

★ Try making a compost pile at home.

OR

★ Draw a picture of what makes a good compost pile in your area.

OR

★ Ask a gardener to come talk to your class about compost.

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11. Reporting

★ Make a class newspaper. Include pictures and stories about soil.

OR

★ Pretend you are a newspaper reporter. You want to write about the reports Mrs. Lucas's students give. Tell the class what stories you will write about. Write some headlines for your stories.

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12. Comparing Soil

Collect samples of soil from around your neighborhood. Put a label on each container that tells where you got the soil.

Compare the samples. How are they alike and how are they different?

- ★ Make a chart or graph showing the different kinds of soil you collected.

OR

- ★ Create a poem or song about the soil you collected.

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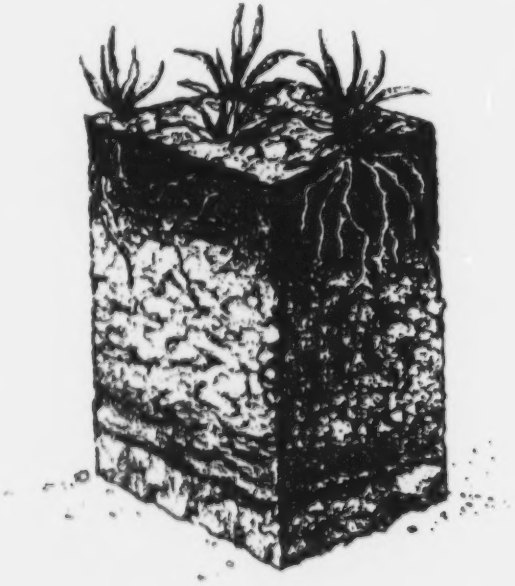
13. Games

★ Make up a game about soil. The game will teach the players about the different kinds of soil. It will also teach about why we need soil.



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14. Growing and Predicting

Put three or four kinds of soil in separate pots. One soil could be rocky. One could be sandy. One could be clay. You choose.

Plant some radishes or beans in the pots. Give the plants the same amount of water. Give them all the same light. Only the soils they are growing in should be different. Make some guesses:

In which soil do you think the seeds will sprout first?

In which soil will they grow fastest?

In which soil will they grow tallest?

★ After you watch the plants grow, tell your class

what happened

why you think it happened

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15. Soil Music

★ Make up a song about Joey's close call with the avalanche.

See if you can find music that would go with some of the scenes of the story:

the ant scene

the nematode scene

the robin scene

the return to the classroom scene

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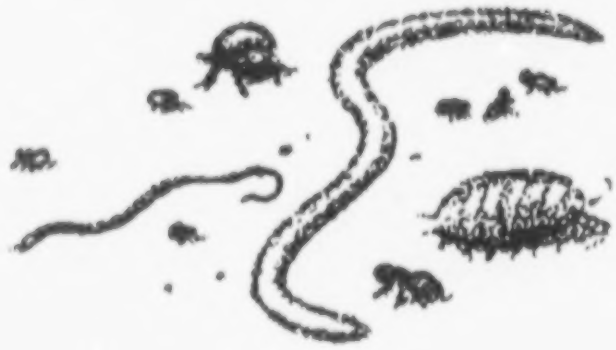
16. More Research

Mrs. Lucas's class saw many things in the soil. What other things might Mrs. Lucas's class have seen?

* Draw a picture or make a diorama showing life in the soil.



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17. You Are the Teacher

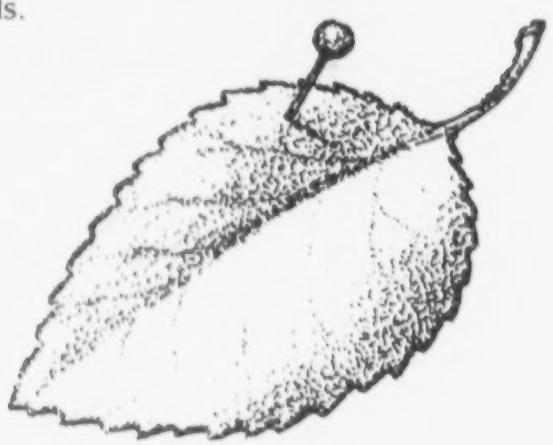
Pretend that you are a teacher. You want your class to learn about soils.

★ Plan a bulletin board that would get your students interested.

Find the materials you need.

Then make the bulletin board you designed.

Ask your classmates what they learned about soils.



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Earth Science

A Multifaceted Investigation of Soil

Name _____ Date _____

Unit 2

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1. Permeability

If we are not careful we shall leave our children a legacy of billion dollar roads leading nowhere except to other congested places like those left behind. We are building ourselves an asphalt treadmill and allowing the green areas of our nation to disappear.

General Omar Bradley

Make a list of areas near your home or school that have been paved within the last three years. How does paving an area affect the permeability of water into the soils? What do you think the link might be between paving areas and flooding?

Take one of the following roles:

city planner	**highway planner**
farmer	**home owner with young children**

★ In a speech or a play give your point of view regarding the following situations:

Kids have worn a bicycle path across a city park and it fills with mud each spring. Should it be paved?

A new highway is needed to connect a tourist area to a metropolitan area. The only available stretch of land is prime farmland. Should the highway be built? Are there other options?

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2. Stories of the Earth

He had no articulate thought of anything; there was only this perfect sympathy of movement, of turning this earth of theirs over and over to the sun, this earth which formed their home and fed their bodies and made their gods. The earth lay rich and dark and fell apart lightly under the points of their hoes. Sometimes they turned up a bit of brick, a splinter of wood. It was nothing. Some time, in some age, bodies of men and women had been buried there, houses had stood there, had fallen and had gone back to the earth. So would also their house, some time, return into the earth, their bodies also. Each had his turn at this earth. They worked together, moving together—together producing the fruit of the earth—speechless in their movement together.

Pearl Buck
The Good Earth

★ Create a story using a portion of the quote. What are the gods that were worshiped? Invent a "god" of the soil and describe the powers this god has.

Look at the list of fiction books listed in the bibliography. Choose one to read. While you are reading it, think of the soil as an important feature of the story.

★ After you are finished reading it, write a one-page report about the soil as an important feature of the story. How would the story be different if the soil were different?

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2. Stories of the Earth *(continued)*

Choose two of the following ideas and use your drawing skills:

- ★ Choose a part of the story that is not illustrated and create your own illustration.
- ★ Draw a picture illustrating soils. Explain on the back of the picture (or on a separate piece of paper) what is represented in your picture.
- ★ Draw a cartoon about soils that illustrates a portion of the story.
- ★ Draw or paint a picture illustrating one of the characters in the story. Explain why you chose to draw the picture the way you did.

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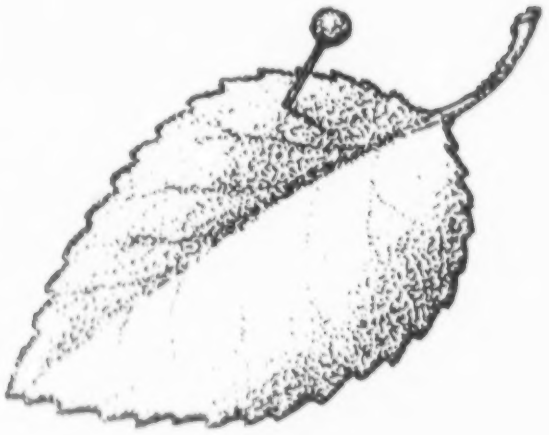
3. You Are the Teacher

Take the role of a teacher who wants the class to read the story about soils.

★ Design a bulletin board that would get your students interested in reading the story.

Find the materials you need to complete your bulletin board and then make the bulletin board you designed.

Survey your classmates. Did the bulletin board pique their interest in the story?



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4. Another Setting

The story is set in modern times. How would the story be different if it were set

in Europe during the Middle Ages?

on the prairie during the depression?

at a landfill during the 1970s?

in upper Michigan during the 1860s when this state was ravaged by forest fires?

Consider the soil characteristics of those time periods as well as the effects of human intervention.

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5. Mud Pony

The Mud Pony tells the story of a young American Indian who fashions a pony from clay. The pony gives the boy strength. He cares for the pony for many years and becomes a chief of his people.

What lessons does the story contain about the treatment of soils?

Why would this be a story that American Indians tell generation after generation?

Find other American Indian legends involving the soil and tell them to your class.

According to legend, how are rocks made? What happens to the leaves as they fall? What planting rituals did some American Indians have in regard to the soil?

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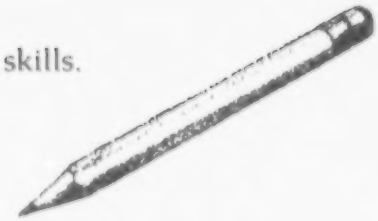
6. Writing about Soil



Choose two of the following language activities and use your writing skills.

- ★ Rewrite the avalanche portion of "Through the Chalkboard" from Joey's perspective.
- ★ Is the narrator a boy or a girl? Does it matter? Why or why not? Write at at least a paragraph answering these questions.
- ★ Rewrite a portion of the story giving obvious clues about the narrator's gender. If you are a boy, write from the viewpoint of a girl, and if you are a girl, write from the viewpoint of a boy.
- ★ What important words related to soil did the author not use in the story? Create a new adventure inside the soil using these new vocabulary words.
- ★ Speculate on the next chalkboard adventure. What might happen when the class visits the rim of an active volcano? What might happen when the class studies rock formation? List some possible places where the action might take place for those two units.
- ★ Take one or more of the "close calls" that the class has and develop it further into a major adventure.
- ★ Pretend you are a particle of soil. Write a diary of what happens to you during a one-week period. Remember who (name your particle of soil), when (summer, fall, winter, spring), where (barnyard, schoolyard, home, park, etc.) and what (trampled on, collected, etc.). Be creative!

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7. Word Search

In this puzzle you will find 20 of the words from the glossary.

G V P Y E H C N A L A V A I P G A Z B
A R R J T E G Z J S N N M T P E Z S N
S D E F C I J I E C U O L V W M D M L
I F Q Z A O L B C B O N Z P D X U O N
J Q N H I N M I E E N M E I C N A L X
G K G I X S E P B R N A P G R M W Y C
Y N V U L L E L O A E T B A S O W G X
E L N K A L N H G S D P I E C Z H E X
R J E L A I A F T U T A O P O T P H B
W B U V S N R T D O E I R B E M I B U
G U Q F A U N E S T P J B G P D A O R
K S T H M R T E T Y T Y U W E E E S N
C Q B H V T G I L C R Z H F Y D Y A T
S R B X U R Z V R I A C W C Y L O N M
Q J E R M M O Q N T D B R F A G E I Q
V E L C C V U H B S E A Q R X F M Y B
R M K C O W J S E X M D V T K E Y Q H
F X E A R T H W O R M A W U N V R R Z
G M K Q X U X A K P E W J B U D J Y X

Look for these words:

amoeba
annelida
avalanche
bacteria
biodegradability
centipede
clump
compaction
compost
crystalline
detritus
earthworm
euglena
genus
gravel
horizon
humus
hypothesize
larva
loam

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8. More Puzzles

★ Make a seek-find puzzle using the glossary section from the story. Seek-find puzzles are in all capital letters.

OR

★ Make a crossword puzzle using the glossary.

Remember to number crossword puzzles from the top down and from left to right.

Both puzzles can be done on graph paper.

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9. Creating a Play

★ With a group of students, write a play based on the story about soils. You may choose one or more scenes from the story. Include a part for each member of your group and be sure to use dialogue carefully to portray the scenery.

Present the play to your class. If you have videotaping equipment available, have someone tape the play.

10. Report

★ Write a one-page report or make a chart or diagram that answers the following question:

What part do the following play in changing soils?

erosion

acid rain

volcanos

poor agricultural practices (not rotating farm crops, using too many pesticides, etc.)

drought

other types of soil pollution (such as oil spills on a shoreline)

OR

★ Write a one-page report or make a chart or diagram that answers this question:

How would a compost pile help gardens produce more?

The nation that destroys its soil destroys itself.

Franklin D. Roosevelt

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11. Debate

★ Organize a debate on the following question:

Can people stop acid rain?

Limit the time of the debate to 3 minutes for presentations of each of the two views and 2 minutes for rebuttal.

Allow one minute between each presentation.

You may want to check Opposing Viewpoint—Environmental Crisis published by Greenhaven Press (1991) for ideas.

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12. Reporting

★ Write a class newspaper with articles about soil and soil conservation. Members of your group could be responsible for the following parts of the newspaper production:

banner headline

illustrations

articles

If you have a newspaper program available on a school computer or a computer at home, use it to make this project easier.

OR

★ You are a newspaper reporter who has been given the assignment of covering the oral class presentations in Mrs. Lucas's earth science class. The newspaper has held the headline and one long column for this story that you will now write.

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13. Comparing Soil

Gather soil samples from areas around your neighborhood and compare the samples. Label the profiles.

Do a compaction comparison test.

First predict which soil would absorb faster: one on a frequently walked path or one in an area where people seldom walk.

Take two tin cans of equal size and cut the tops and bottoms out of both cans. Push one can into the soil in an area that is seldom walked on. Push the other can into a much-used path or area. Pour an equal amount of water into each can. Use a stopwatch or other timepiece to calculate the amount of time it takes the soil to absorb the water in each can.

Which area absorbed the water faster? Why?

★ Write a conclusion to the experiment that evaluates the connection between the amount of compaction and the number of pore spaces within the soil and the soil's ability to absorb water.

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14. More Comparison

Compare soils in their ability to take in water. Use the soil samples that you have gathered. Also use prepared samples that are mostly sand and samples that are mostly coarse gravel. Use beakers of exactly the same size for the comparison and pour 150 milliliters of water into each sample.

If the soil sample is 300 milliliters or more, where on the side of the beaker does the water stop? Is it above the surface of the soil? If so, that indicates soil with a poor permeability. If the water is close to the 150 milliliter mark on the side of the beaker, the soil is permeable.

Why do we need both permeable and impermeable soils? Which would be the better soil for a ground nesting bird? Why?

If you were responsible for burying toxic materials in the soil, which soil type would you pick? Why?

Which soil type would be best for plants that do not have a main tap root? Why?

In which soil type would you most likely find plants with long tap roots? Why?

If a permeable soil were found above an impermeable soil, what consequences might it have for the movement of water in the system?

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15. Growing and Predicting

Grow plants (radishes or beans will work well) in different soil types. Keep all other variables constant. Make predictions about the following:

Which soil type provides for the first germination?

Which soil type provides for the fastest growth?

Which type provides for the tallest plant?

★ After making your predictions and watching the plants grow, collect data and graph the results.

Draw some conclusions as to soil types and plant germination from this experiment.

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16. Soil Music

- Write lyrics to a rap or other song describing Joey's close call with the avalanche.

  Find music that would be appropriate for the different scenes of the story:

  the ant scene

  the nematode scene

  the robin scene

  the return to the classroom scene

The soil is the source of life, creativity, culture, and real independence.

David Ben-Gurion

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17. Graphing and Modeling

Choose two of these activities:

- ★ Graph the permeability of different soil samples in a bar graph.
- ★ Make a model of the "typical siliceous sand particle" mentioned in the story. Why is it shaped like this?
- ★ Make a chart showing the siliceous structure of sand. Use stencils to label the structure.

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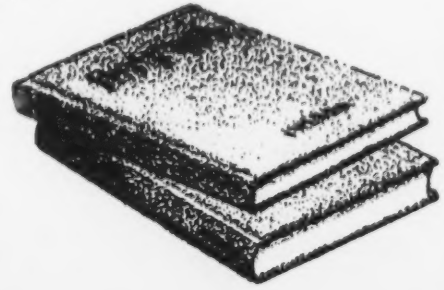
18. Research

Check three different encyclopedias under SOIL. Write down the names of the encyclopedias, the copyright dates, and the number of pages the article covers. You may use a CD-ROM if you would like. Check the number of screens that each encyclopedia contains on the topic of soil. Note which electronic encyclopedias you accessed. Then answer the following questions about your encyclopedia search.

Were there any illustrations? (In the case of CDs, was there any sound or motion in the SOIL section?) If so, compare. Which encyclopedia had the best illustrations?

Were there any cross-references (SEE or SEE ALSO)? Which subjects could you look up to help you with soils? Look up at least one. Would you find the cross-references helpful in writing a report on soils? Why or why not? What major differences were there in the articles themselves? Which encyclopedia do you feel would be the most helpful if you had to write a two-page report? Why?



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19. More Research

Research the life cycle of any of the organisms mentioned in the story. Are there organisms that are common in the soil that could have been mentioned?

- ★ List any other organisms that might have been seen by Mrs. Lucas's class if they had returned to the soil.

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20. Computer Work

★ If you have a computer available to you, program your own adventure using the kids in the story. The following example uses DOS QBASIC:

```
5 REM WORM.BAS the robin scene
10 CLS
20 PRINT "You're only slightly larger than a soil particle and a potential"
25 PRINT "tasty morsel for a Turdus migratorius"
30 PRINT "You hear the characteristic flapping of its approach"
40 PRINT
50 PRINT "You must think fast!"
60 REM this section shows your choices
70 PRINT
80 PRINT "Do you . . ."
85 PRINT
90 PRINT "(1) STAND STILL AND WAIT TO SEE WHAT HAPPENS?"
100 PRINT "(2) BURROW YOUR WAY FURTHER INTO THE SOIL ?"
110 PRINT "(3) RUN FOR THE NEAREST HIDING PLACE?"
120 PRINT "TYPE IN YOUR CHOICE AND PRESS ENTER"
130 INPUT CHOICE
140 IF CHOICE = 2 THEN GOTO 210
150 IF CHOICE = 3 THEN GOTO 260
160 IF CHOICE = 1 THEN GOTO 60
170 REM CHOICE 1 stand still and wait to see what happens
180 PRINT "Your ability to stand as still as a statue saves you!"
182 PRINT
```

(continued)

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20. Computer Work *(continued)*

```
185 PRINT "The robin is startled by passing car and hops away from you."
187 PRINT
190 PRINT "Congratulations! You're still alive to face more challenges!"
200 END
210 REM CHOICE 2 burrow your way further into the soil
220 PRINT "Sorry! Your wiggling movement convinced the robin you were
    edible!"
225 PRINT
230 PRINT "Luckily he settled for digesting your expensive air pump ath-
    letic shoes!"
235 PRINT
240 PRINT "He's going to have one heck of a stomach ache when those
    shoes"
245 PRINT "pump up in his intestine!"
250 END
260 REM CHOICE 3 run for the nearest hiding place
270 PRINT "Chicken! But it worked! As you cower in your paper cup hid-
    ing place"
275 PRINT "you can think about tomorrow"
276 PRINT
280 PRINT "and . . . another science project!"
290 END
```

Computer example adapted from an example in *Building with Basic: A Programming Kit for Kids* by Gayle Arthur (Alpha Books, 1992).

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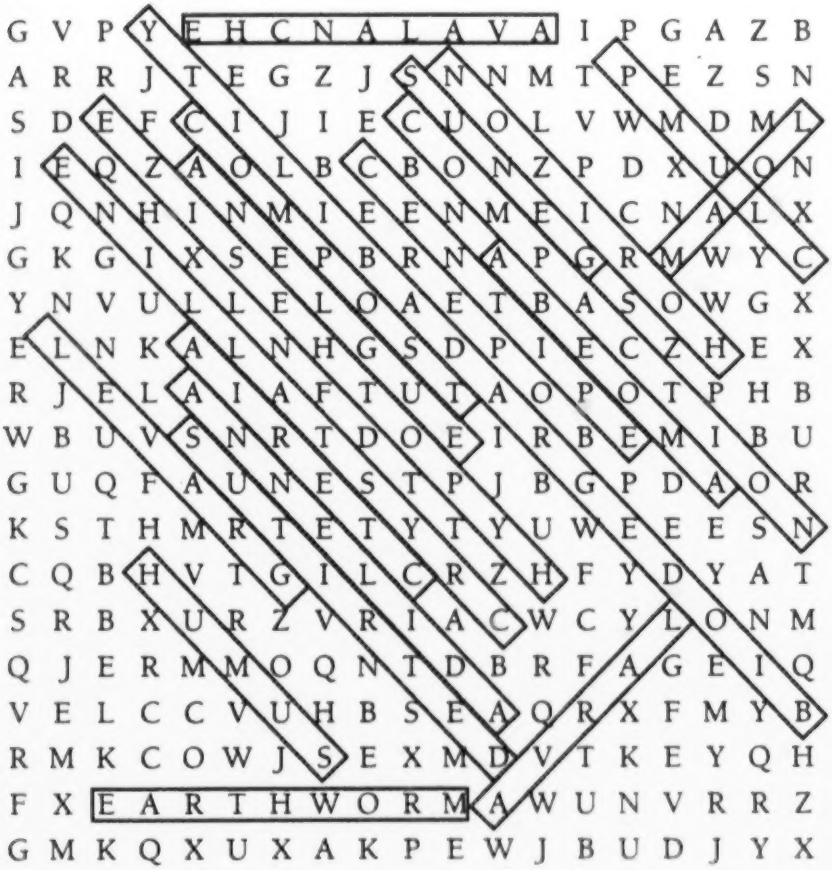
Answers to Word Search


G V P Y E H C N A L A V A I P G A Z B
A R R J T E G Z J S N N M T P E Z S N
S D E F C I J I E C U O L V W M D M L
I E Q Z A O L B C B O N Z P D X U O N
J Q N H I N M I E E N M E I C N A L X
G K G I X S E P B R N A P G R M W Y C
Y N V U L L E L O A E T B A S O W G X
E L N K A L N H G S D P I E C Z H E X
R J E L A I A F T U T A O P O T P H B
W B U V S N R T D O E I R B E M I B U
G U Q F A U N E S T P J B G P D A O R
K S T H M R T E T Y T Y U W E E E S N
C Q B H V T G I L C R Z H F Y D Y A T
S R B X U R Z V R I A C W C Y L O N M
Q J E R M M O Q N T D B R F A G E I Q
V E L C C V U H B S E A Q R X F M Y B
R M K C O W J S E X M D V T K E Y Q H
F X E A R T H W O R M A W U N V R R Z
G M K Q X U X A K P E W J B U D J Y X

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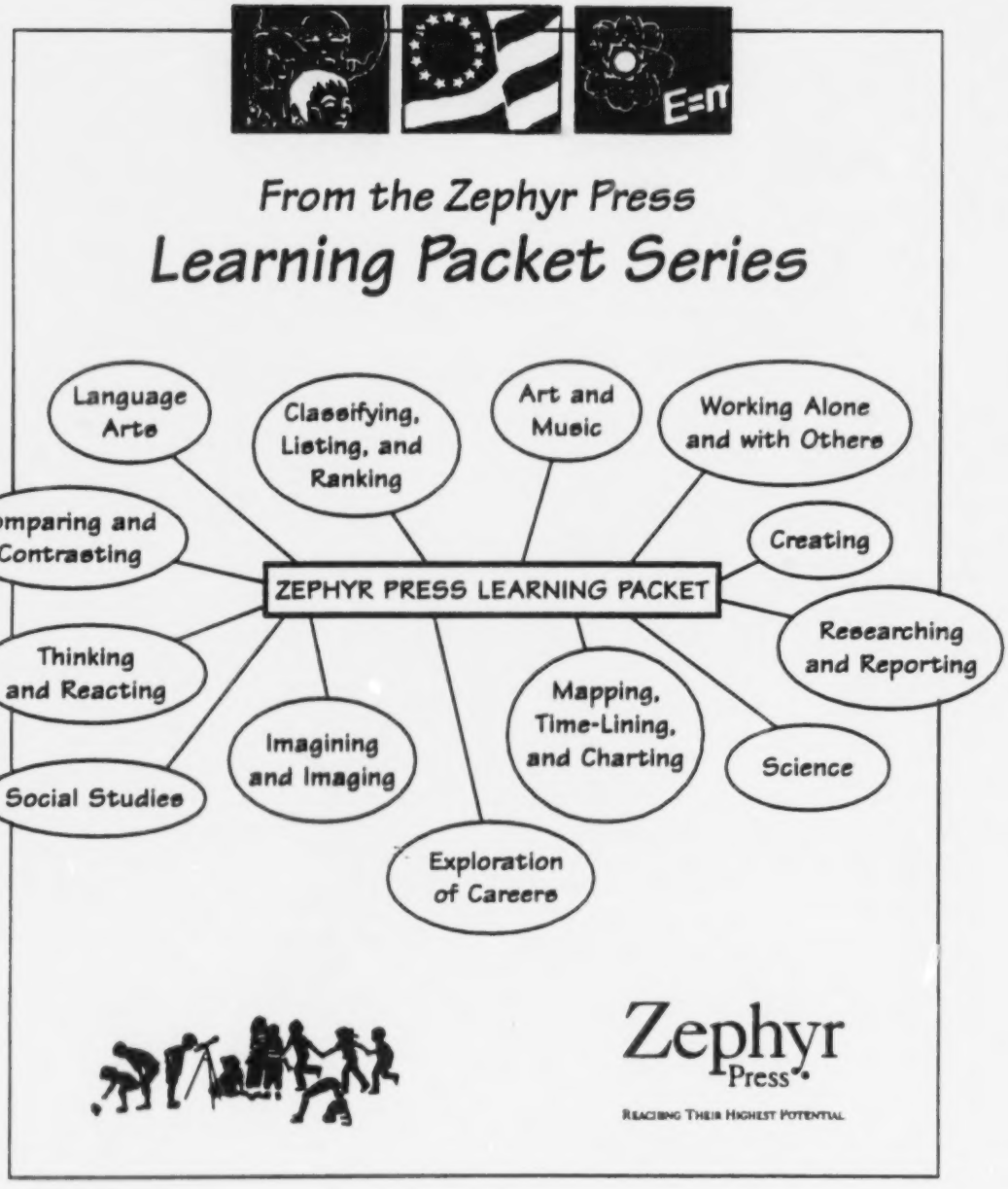

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